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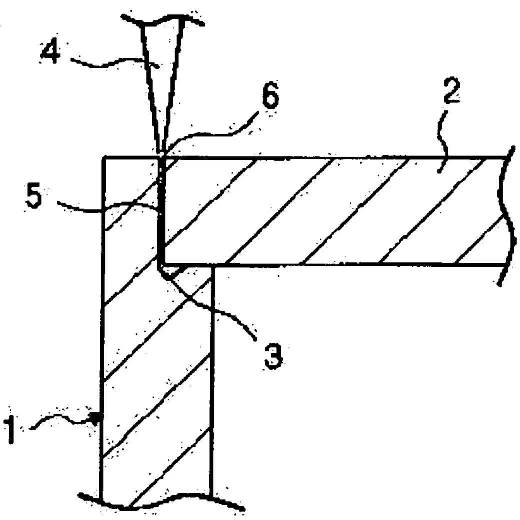
(54) METHOD FOR ELECTRON BEAM WELDING OF ALUMINUM OR ALUMINUM ALLOY MATERIAL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for electron beam welding of aluminum or an aluminum alloy material which does not create weld defects, which is excellent in safety and which yields high joint strength.



SOLUTION: A first member 1 and a second member 2 made of an aluminum plate or an aluminum alloy plate are prepared, and an L-shaped notch 5 is provided on the end face of the first member 1. On the base corner of the notch 5, a groove 3 is formed. After erecting the first member 1 vertically with the end face on which the notch 5 is formed directed upward, and after making the tip part of the second member 2 horizontal, the second member 2 is fitted to the notch 5 of the first member 1, thereby forming a square joint. Subsequently, both members are welded by irradiating a joint formed between the first member 1 and the second member 2 with an electron beam 4 from the end face side of the first member 1. At this time, when the thickness of a part on which the notch 5 of the first member 1 is provided is t mm, the width of the base of the notch 5 is f mm, the width of the groove 3 is g mm and the depth of the groove 3 is h mm, g must be $\leq 0.4f$ and h must be $\leq 0.5t$.

LEGAL STATUS

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] The configuration of a weld zone is especially stabilized by this invention about the electron-beam-welding approach of the aluminum which carries out electron beam welding of the weld zones, such as a square shape splice, or an aluminum alloy, and it relates to the electron-beam-welding approach of the aluminum from which high bonding strength is obtained, or an aluminum alloy while it is good.
[0002]
[Description of the Prior Art] In recent years, in transportation equipments, low-fuel-consumption-izing and improvement in the speed are demanded, and more nearly lightweight structure is adopted. And the lightweight aluminum instead of or aluminium alloy material is used as an ingredient of these structures. [iron steel materials] Hereafter, aluminum or aluminium alloy material is named generically, and it is only called aluminum material. There are rolled stock, an extruded section, cast material, etc. as such aluminum material from the difference in the manufacture approach, and it is used also for various welded structures.
[0003] Usually, it is joined by welding which makes arc welding a subject, and aluminum material is included in the welded structure. However, aluminum material has the property in which deformation by the welding heat, distortion, and residual stress are large, and was not able to obtain a large operating experience from the reason of the cost for repairing these deformation, distortion, and residual stress becoming high about the arc welding of aluminum material.
[0004] On the other hand, since the energy density is high, a laser-welding method is a high speed and is high, and it has been widely used for welding processes, such as steel materials, as a welding process with little distortion. [of efficiency] Moreover, since there are little the deformation and distortion under the effect of the welding heat, to raise welding efficiency is tried by using welding processes, such as butt welding or a lap welding, and joining the aluminum material which is easy to receive a thermal effect by the laser-welding method.
[0005] Drawing 7 (a) is the mimetic diagram showing the size of the slot at the sectional view showing conventional aluminum or the laser-welding approach of aluminium alloy material, the (b) notch, and its base of a corner (JP,10-156564,A). As shown in drawing 7 (a), the conventional laser-welding approach prepares the part I material 101 and the part II material 102 which consist of aluminum or an aluminium alloy plate, and forms the L character-like notch 105 in the end face of the part I material 101. The slot 103 on the configuration which meets a corner at that corner base side is formed in this notch 105. And the end face in which the notch 105 was formed is turned up, the part I material 101 is stood perpendicularly, the edge of the part II material 102 is horizontally arranged to this notch 105, this is fitted into it, and a square shape splice is formed in it. Next, weldbonding of both is carried out to the splice formed between the part I material 101 and the part II material 102 by irradiating carbon dioxide gas laser 104 from the groove section 106 between the part I material 101 and the part II material 102.
[0006] Moreover, if thickness of the edge of t (mm) and the part II material 102 is set to T (mm) for the

thickness of partial 101a in which the notch 105 of the part I material 101 was formed as shown in drawing 7 (a) and (b), by making t into 25 of T thru/or 75%, also by processing of low-power output, it considers as a perfect fusion zone and improvement in splice reinforcement is aimed at. Moreover, improvement in the effectiveness of preventing generating of the effectiveness of holding aluminum or an aluminium alloy molten metal, the effectiveness which melts and controls generating of omission, and a weld flaw etc. is aimed at by setting it to h<=2/3t, while setting distance across vee of a notch 105 to g<=0.5f, when the depth of g (mm) and a slot 103 is set to h (mm) for the width of face of f (mm) and a slot 103.

[0007] Moreover, the electron beam welding which welds by making an electron beam into a heat source occurs. This is a welding process which restrains the electron beam of the high speed which accelerates an electron and is obtained in a vacuum with a focal coil, applies an energy density to height and a base material, and is performed using impact generation of heat at the time, and is used for welding of various metals, such as alloy steel besides welding of active metals, such as a zirconium and niobium, a stainless steel rope, aluminum, and copper. Deep penetration is easy to be obtained, although, as for laser welding, energy gas is absorbed in a shielding gas ambient atmosphere, on the other hand in order to weld electron beam welding in a vacuum. Moreover, since energy density is max also in the various sources of the welding heat, it can weld at high speed, the width of face of a heat affected zone is narrow, and there is little distortion.

[0008]

[Problem(s) to be Solved by the Invention] However, if electron beam welding of the aluminum material is carried out, the unstable keyhole resulting from the effect of metallic fumes will be formed, and this will be easy to produce a porosity defect. Moreover, the air bubbles with which a coagulation rate causes a porosity defect since it is quick compared with arc welding and laser welding not only tend to remain, but as for the melting deepest part used as the tip of a keyhole, expansion at the time of melting and contraction at the time of coagulation are performed rapidly. Therefore, the aluminum material which has the notch of the configuration of the conventional example mentioned above is used, and when energy is very high and welds to a high speed by electron beam welding with the narrow width of face of a heat affected zone, the trouble of becoming easy to generate a coagulation crack defect is in the weld zone of aluminum material.

[0009] This invention is made in view of this trouble, and does not have a weld flaw, and while safety is excellent, it aims at offering the electron-beam-welding approach of aluminum with high splice reinforcement, or an aluminum alloy.

[0010]

[Means for Solving the Problem] The electron-beam-welding approach of the aluminum concerning this invention, or an aluminum alloy The part I material and the part II material which consist of aluminum or an aluminium alloy Prepare a L character-like notch in the end face of the part I material, and the edge of said part II material is fitted in and arranged towards becoming right-angled to said part I material to said notch. It is the electron-beam-welding approach which carries out electron beam welding of both from the end-face side of said part I material. When the slot on the configuration along said corner was formed in the corner base side of the notch of the shape of said L character, distance across vee of t (mm) and said notch was set to f (mm) for the thickness of the edge of said part I material, width of face of said slot is set to g (mm) and said depth of flute is set to h (mm), It is characterized by setting g to 0.4f or less, and setting h to 0.5t or less.

[0011] In this invention, by preparing a notch in the part I material, a fitting location with the 2nd member can be made exact, the gap at the time of welding can be controlled, and the stable weld zone can be formed. This notch size is not specified especially that what is necessary is just the magnitude into which the part I material and the part II material can fit. Moreover, in the electron beam welding from which deep penetration is obtained, metallic fumes, hydrogen, etc. which occur at the time of welding and cause a blowhole can be emitted outside through a slot by forming the slot on the configuration along this corner, and specifying the width of face and the depth of that slot to the corner base side of the notch of the shape of L character prepared in the part I material further. Moreover, since

the restraint of the melting deepest part becomes weaker by this slot, weld cracking can be controlled.
[0012] however , in the fusion zone used as deep penetration , when the width of face g of this slot and depth h be 0 (i.e. , when not form a slot) , since melting from which a crack become a cause , and the restraint at the time of coagulation will be heighten , the yield of a defect increase by about [that the gas which serve as a generation source of a porosity defect at blowhole lists , such as metallic fumes , hydrogen , and shielding gas , cannot be discharge outside] , and the melting deepest part . On the other hand, if g exceeds 0.4f or h exceeds 0.5t, the stewing force will decline, the molten metal it became impossible to hold into a slot will melt and fall, and it will become easy to generate under-filling or an undercut as a result. Therefore, the slot formed in the corner base side of a notch sets h to 0.5t or less while setting g to 0.4f or less.
[0013] In addition, in the joint geometry of this invention, if the include angle which the part I material and the part II material make does not need to be strictly right-angled and is substantially right-angled, it can apply this invention.
[0014]
[Embodiment of the Invention] Hereafter, the example of this invention is concretely explained with reference to an attached drawing. Drawing 1 is the sectional view showing the laser-welding approach of the aluminum concerning the 1st example of this invention, or aluminium alloy material. First, the part I material 1 and the part II material 2 which consist of aluminum or an aluminium alloy plate are prepared, and the L character-like notch 5 is formed in the end face of the part I material 1. The slot 3 on the configuration along a corner is formed in the corner base side of the notch 5 of the shape of this L character. And the end face in which this notch 5 was formed is turned up, the part I material 1 is stood perpendicularly, the edge of the part II material 2 is horizontally arranged to this notch 5, this is fitted into it, and a square shape splice is formed in it. Next, weldbonding of both is carried out by irradiating an electron beam 4 to the splice formed between the part I material 1 and the part II material 2 from the groove section 6 between the part I material 1 and the part II material 2.
[0015] In this invention, there is no weld flaw, and while safety is excellent, in order to obtain a weld zone with high splice reinforcement, the width of face and the depth of a slot 3 are specified. Drawing 2 and drawing 3 are the typical sectional views showing the size of the notch 5 formed in the part I material 1 list at this, and a slot 3. As shown in drawing 2 , as distance across vee of t (mm) and a notch 5 is set to f (mm) and it is shown in drawing 3 , the thickness of the part I material 1 in which the notch 5 is formed When width of face of the slot currently formed in the corner base side of a notch 5 is set to g (mm) and the depth of flute is set to h (mm), the effectiveness of preventing generating of a weld flaw improves by setting g to 0.4f or less, and setting h to 0.5t or less.
[0016] If according to this example the slot 3 on the configuration along this corner has predetermined width of face and the predetermined depth and is formed in the corner base side of the notch 5 of the shape of L character prepared in the part I material 1, metallic fumes, hydrogen, etc. which occur at the time of welding and cause a blowhole etc. can be discharged outside through this slot 3. Moreover, by this slot, since the restraint of the melting deepest part becomes weaker, weld cracking can be controlled and the configuration of a weld zone can be made good.
[0017] In addition, in this invention, especially the welding condition of the electron beam welding applied to aluminum or an aluminum alloy is not limited. Moreover, the class of welding material etc. can be suitably changed in the range which can acquire the splice quality demanded, and especially limitation is not carried out.
[0018] Moreover, this invention is applicable also to the member of the configuration of other classes, although mainly applied to the electron beam welding of aluminium alloy extruded sections.
[0019] Moreover, in this invention, especially as long as a position of weld is a posture in which safety is securable, it may not be limited, but which a facing up, facing down, and sideways posture is sufficient as it.
[0020]
[Example] Hereafter, the example of the electron-beam-welding approach of the aluminum concerning this invention or an aluminum alloy is concretely explained as compared with the example of a

comparison.

[0021] Drawing 4 is the perspective view showing the joint geometry of this example. Various width of face g of the slot 3 formed in the corner base side of the notch 5 formed in aluminum or aluminium alloy material and depth h of a slot 3 were changed, and as shown in drawing 4 , according to the above-mentioned approach, electron beam welding of the cylindrical shape material 12 and the circle profile 11 was carried out. At this time, the L character-like notch 5 was formed in the cylindrical shape material 12. In the cylindrical shape material 12, it is JIS. In the circle profile 11, it is JIS again about that A6063 extruded section and whose thickness are 10mm. It was used, respectively, having processed A5083 plate and the thing of 10mm of board thickness into the predetermined configuration, the cylindrical shape material 12 which formed the L character-like notch 5 was stood perpendicularly, the circle profile 11 was fitted into that notch 5, and the electron beam was irradiated and welded downward to this fitting section. The electron beam whose output is 30kW and whose welding current (electron current) is 100mA was used for this electron beam welding, and the speed of travel was considered as a part for 150cm/. And it is JIS to the weld zone after electron beam welding. While carrying out the radiographic examination according to Z3105, the quality of a weld zone was evaluated by observing a cross section.

[0022] Drawing 5 is the sectional view showing the weld zone at the time of carrying out laser welding on the conditions which obtain penetration penetration, and drawing 6 is the graphical representation showing the quality evaluation of the weld metal 13 in the case of the partial penetration which takes depth h of a slot 3 along an axis of ordinate, takes the width of face g of a slot 3 along an axis of abscissa, and is shown in drawing 5 . However, in drawing 6 , f and t are board thickness [of distance-across-vee / of the notch of the shape of L character prepared in the aluminum cylindrical shape material 12, respectively / f (mm), and the edge of the aluminum cylindrical shape material 12] t (mm). As the quality evaluation approach, the radiographic examination estimated the penetration situation by observing the generating situation of the defect of a weld metal 13. In addition, in drawing 6 , while the results of a radiographic examination are 1 thru/or the 2nd class, a crack with a die length of 0.1mm or more produced in the cross section makes good 0 thru/or the thing generated one piece, and what the results of a radiographic examination are 3 thru/or the 4th class, or two or more crack defects generated is shown as x.

[0023] As shown in drawing 6 , while the width of face of a slot 3 was below 0.4f (mm), the weld metal of the quality which was excellent in depth h being below 0.5t (mm) was able to be obtained. On the other hand, the stewing force became inadequate, when the width of face g of a slot 3 exceeded 0.4f (mm) or depth h exceeded 0.5t (mm). Moreover, since it became impossible to have held the molten metal, the welding configuration on the rear face of welding of an aluminum plate was confused, the stability of a weld zone was checked, and, thereby, the weld flaw occurred.

[0024]

[Effect of the Invention] If according to this invention approach the part II material is fitted into the notch of the part I material and electron beam welding is carried out to it by preparing a L character-like notch in the part I material, and forming the slot which specified that width of face and depth on the corner base of this notch, as explained in full detail above, while raising the configuration of a weld zone, a weld flaw is prevented, it excels in safety, and high splice reinforcement can be obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the laser-welding approach of the aluminum concerning the example of this invention, or aluminium alloy material.
[Drawing 2] It is the mimetic diagram showing the size of the part I material of this invention.
[Drawing 3] It is the mimetic diagram showing the size of the slot 3 at the base of a corner of the notch of this invention.
[Drawing 4] It is the perspective view showing the example of the joint geometry which can apply this invention.
[Drawing 5] It is the sectional view showing the weld zone at the time of carrying out laser welding on the conditions which obtain penetration penetration.
[Drawing 6] It is the graphical representation showing the quality evaluation of the weld metal 13 in the case of the partial penetration which takes depth h of a slot 3 along an axis of ordinate, takes the width of face g of a slot 3 along an axis of abscissa, and is shown in drawing 5 .
[Drawing 7] The sectional view in which (a) shows conventional aluminum or the laser-welding approach of aluminium alloy material, and (b) are the mimetic diagrams showing the size of the slot at a notch and its base of a corner.
[Description of Notations]
1,101; part I material
2,102; part II material
3,103; slot
4; electron beam
5,105; notch
11; circle profile
12; cylindrical shape material
13; molten metal
104; carbon dioxide gas laser

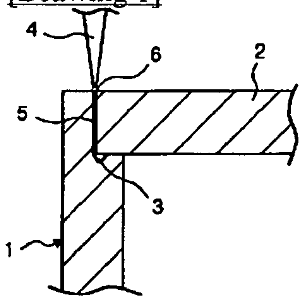
[Translation done.]

* NOTICES *

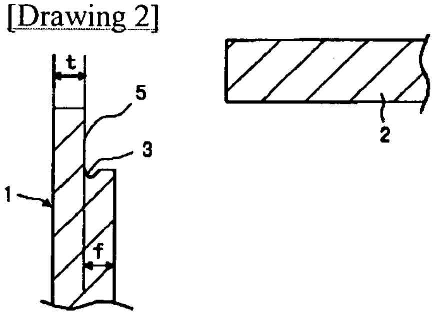
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

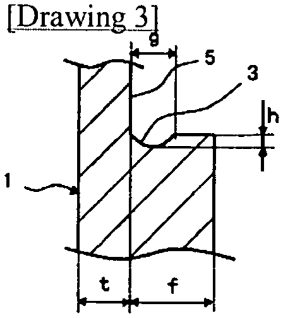
[Drawing 1]



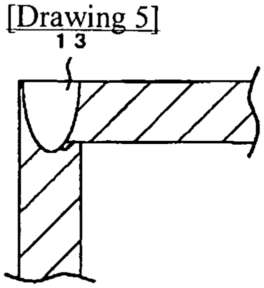
[Drawing 2]



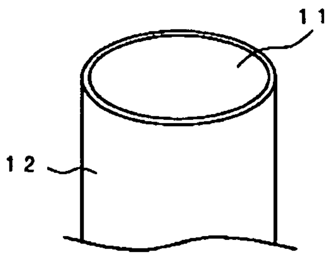
[Drawing 3]



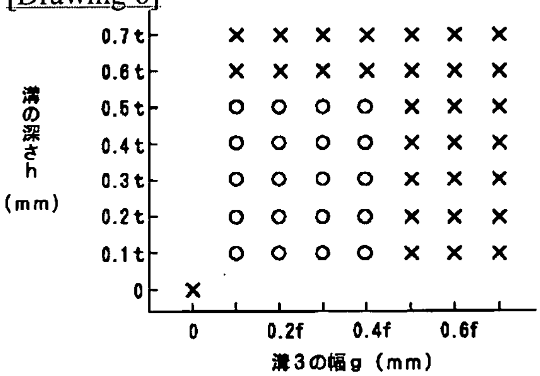
[Drawing 5]



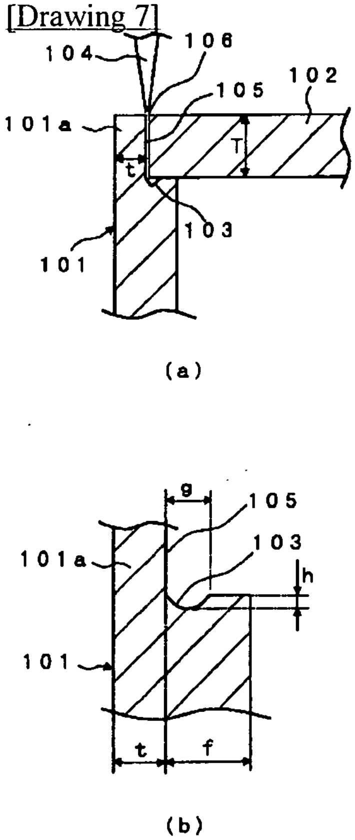
[Drawing 4]



[Drawing 6]



[Drawing 7]



[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The part I material and the part II material which consist of aluminum or an aluminium alloy Prepare a L character-like notch in the end face of the part I material, and the edge of said part II material is fitted in and arranged towards becoming right-angled to said part I material to said notch. It is the electron-beam-welding approach which carries out electron beam welding of both from the end-face side of said part I material. When the slot on the configuration along said corner was formed in the corner base side of the notch of the shape of said L character, distance across vee of t (mm) and said notch was set to f (mm) for the thickness of the edge of said part I material, width of face of said slot is set to g (mm) and said depth of flute is set to h (mm), The electron-beam-welding approach of the aluminum characterized by setting g to 0.4f or less, and setting h to 0.5t or less, or an aluminum alloy.

[Translation done.]